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FACSIMILE COVER SHEET

To: Sheela C. Chawan Art Unit 2621	From: John Smith-Hill
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Anil M. MURCHING et al

Application No: 09/318,682

Filed: May 25, 1999

For: KALMAN TRACKING OF COLOR OBJECTS

Art Unit: 2621

Examiner:
Sheela C. Chawan

AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please make the following amendments to this application.

AMENDMENTS

In the Description:

Rewrite the paragraph beginning on page 5, line 4, to read as follows:

B1

Kalman tracking applies a Newtonian motion model to the centroids of the objects of interest. As an example, the objective is to track object #K in Fig. 3, whose location in the starting frame I_0 of the input video image sequence is identified by the user. Object #K belongs to color model #A while a different object #L belongs to color model #B. The user "clicks" on the estimated location of the centroid (geometric center) of the object #K and thereby identified the object #K as an object of interest. The Kalman state vector at time "n" is:

$$\underline{\zeta}_k[n] \triangleq \begin{vmatrix} x_k[n] \\ y_k[n] \\ v_{xk}[n] \\ v_{yk}[n] \end{vmatrix}$$

where (x_k, y_k) are the location coordinates of the centroid for object #K, and (v_{xk}, v_{yk}) are the velocity components of object #K. The

B1 Newtonian motion model for all objects assumes that acceleration is a white-noise process. This motion model is well known in the art and may be found in the literature on Kalman filtering.

Rewrite the paragraph beginning on page 7, line 17, to read as follows:

B2 For the initialization of the process the position of the centroid in frame I_0, $\underline{\xi}_k''[0|0]$, is determined. The user "clicks" near the visually estimated geometric center of the object #K, and that point serves as the initial position. The initial velocity is set to zero. Then values for $\underline{R}_k^s$, $\underline{R}_k^o$ and $\Sigma_k[0|0]$ are determined experimentally and used to determine the centroid position. One such set is

$\underline{R}_k^s = |2.0,\ 0;\ 0,\ 8.0|$; $\underline{R}_k^o = |1,\ 0;\ 0,\ 2|$; $\Sigma_k[0|0] = |1.6,\ 0,\ 0,\ 0;\ 0,\ 3.2,\ 0,\ 0;\ 0,\ 0,\ 2.0,\ 0;\ 0.\ 0,\ 0,\ 4.0|$

Rewrite the paragraph beginning on page 8, line 9, to read as follows:

B3 Sometimes, due to the geometric shape of the object or due to sudden changes in acceleration, the Kalman prediction points to a centroid location that is outside the boundary of the object #K, as shown in Fig. 5. This situation arises when the PxQ block that contains the predicted centroid position is classified by the color segmentation algorithm as belonging to a class other than color model #A. Again this situation is easily detected. To recover from this, search around a local neighborhood of the predicted centroid position. As shown in Fig. 6, begin at the PxQ block that contains the predicted centroid position and examine PxQ blocks in a spiral search pattern until one is found that belongs to color model #A. Then grow a connected region around this block and label it as object #K in frame I_{n+1}. The radius of the spiral search is a parameter that may be adjusted for each input video image sequence. If the objects of interest move slowly and are "convex" in shape, then a small search radius, such as a 5x5 neighborhood, is generally sufficient. If there is rapid and random motion, then a larger search range is desired.

Rewrite the paragraph beginning on page 9, line 16, to read as follows:

For option (I) the color segmentor outputs a segmentation map S_{n+1}. See Fig. 8. Each sample in S_{n+1} represents a spatially corresponding PxQ block of frame I_{n+1}. The value of the sample "n" is $\{0, 1, \ldots, N_u\}$, where $\{1, \ldots, N_u\}$ are the color models provided to the color segmentor and {0} represents "garbage". The segmentation map is converted to a binary alpha map α_{n+1} by tagging all samples as S_{n+1} that have the same color model as object #K. Thus pixels in α_{n+1} have a value 255 if their corresponding PxQ block in I_{n+1} has the same color as object #K, and have a value of 0 otherwise. The alpha map is fed to a "grow connections" algorithm (Fig. 9) along with the block coordinates of the predicted position of the centroid of object #K. The output is the desired connected region that is tagged as the object of interest. A simple error recovery scheme begins by detecting all connected regions in frame I_{n+1} that have the same color as object #K, and then selects the biggest one among them.

B4

REMARKS

The amendments for the paragraphs starting at page 5, line 4, and page 9, line 16, are for clarification. The amendments for the paragraphs starting at page 7, line 17, and page 8, line 9, are for correction of obvious errors.

Respectfully submitted,

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John Smith-Hill

Date 7/8/02